

## THE GENUS *XEROCOMUS* QUELET IN NORTHERN CALIFORNIA

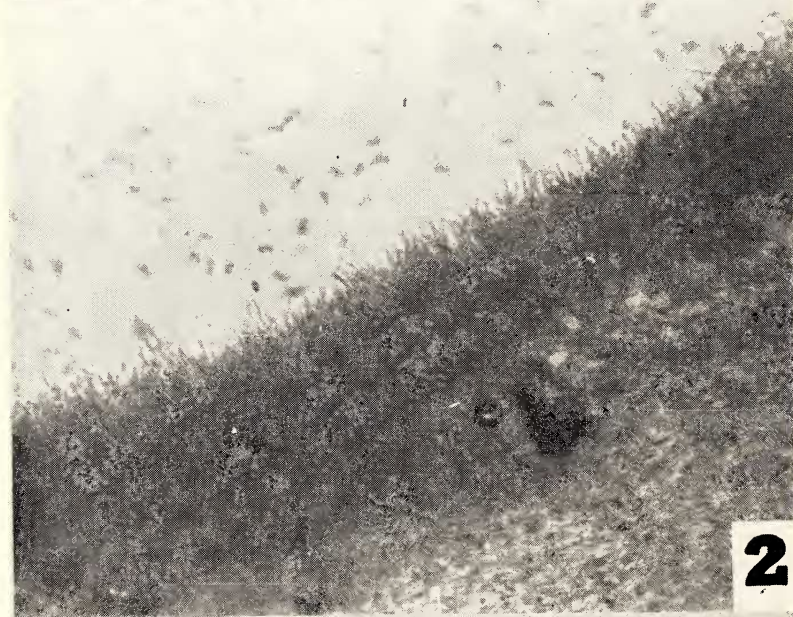
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During the past four years considerable attention has been given to the mushroom flora of the coastal redwood region of central and northern California. The areas studied most intensively include Jackson State Forest in Mendocino County and forested portions of Marin and Santa Cruz counties. The bolete flora of these areas has received special emphasis. As the study progressed it became apparent that there were several groups of closely related species in which determinations were consistently difficult. One such group was composed of the bolete species belonging to the genus *Xerocomus* Quelet, and this paper presents the results of an attempt to more clearly delineate the California species belonging to that genus.

Special gratitude is extended to J. E. Sindel, Forest Manager, Jackson State Forest, Forestry Division of California for his wholehearted cooperation and generosity in placing facilities of the state forest at our disposal during the collecting periods in the fall of the year.

Macroscopically the chief distinguishing characteristics of this genus are the tomentose to velutinous to less commonly pruinose surface of the pileus which is typically dry except for *Xerocomus badius* (Fries) Kuhn. ex Gilb., common in the midwest and northeast, which is viscid. Also, the pileus surface frequently becomes conspicuously rimose to areolate, especially with age. The flesh of the pileus is usually yellow or pallid and changes to blue upon exposure in several species. The taste of the flesh is typically mild or slightly acid. The hymenophore or tubes do not readily separate from one another and are some shade of yellow. They are typically depressed to arcuate around the stipe and frequently have large, compound pores which are concolorous with the body of the tube. The hymenophore, like the flesh, often changes to blue when bruised. The stipe is typically equal or subequal to clavate, never appearing truly bulbous, and the surface is typically dry and glabrous to occasionally reticulate. Although the surface may appear granulose, the granules are not similar to those on the stipe of *Suillus* S. F. Gray species.

The microscopic features of these fungi include smooth or perhaps obscurely roughened to striate spores that are typically subfusoid to subcylindric in outline. The cystidia are often abundant but typically inconspicuous because of the very thin wall and hyaline contents. At times, however, they may become incrustated, particularly around the pores, and stain ochraceous to brown when mounted in a solution of potassium hydroxide. According to Singer (1945b) the most distinctive microscopic feature is the obscurely divergent to subparallel tube trama which is in contrast to the noticeably divergent trama in other genera. As has been



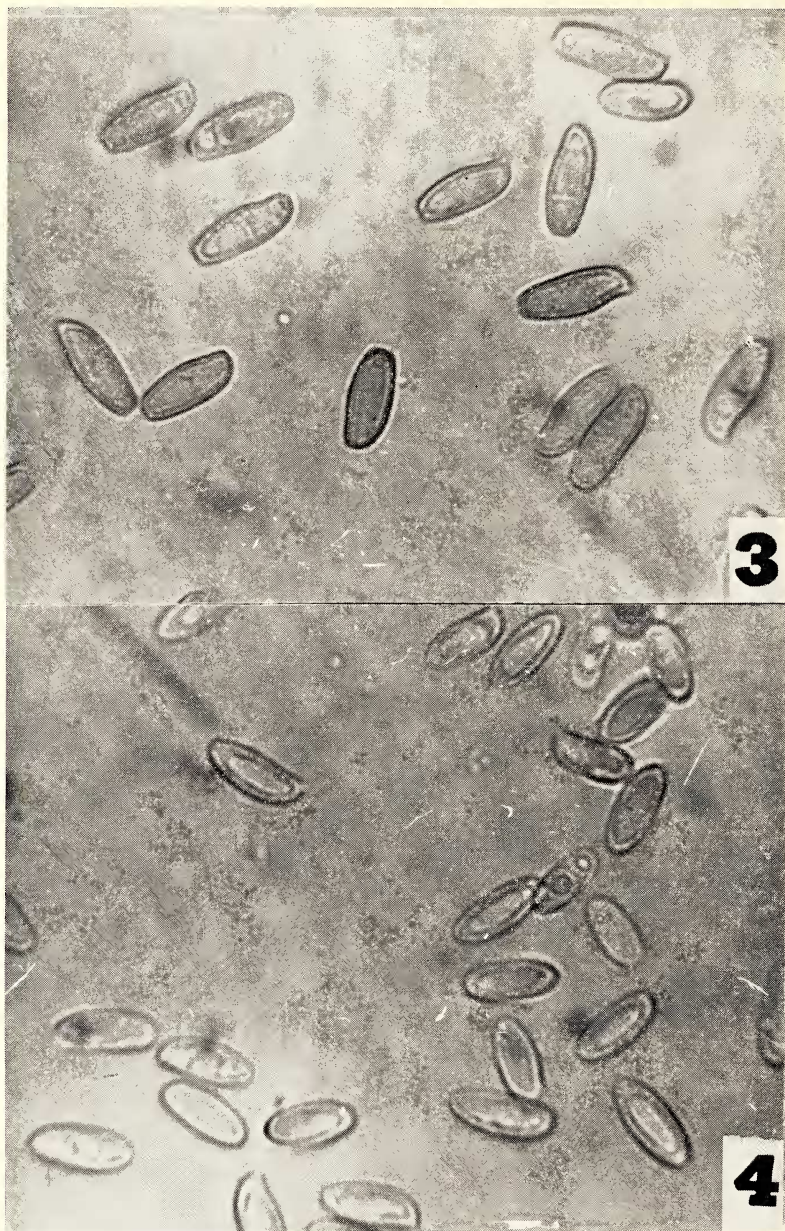
FIGS. 1-2. Cuticle of *Xerocomus*: 1. *X. chrysenteron*,  $\times 500$ ; 2, *X. zelleri*,  $\times 500$ .

pointed out by Snell and Dick (1958), however, there are all degrees of intergradation of this character and unless very young specimens are available it is of little value. The cuticle is usually highly differentiated and varies from a layer of interwoven, heavily incrustated hyphae (fig. 1) to more or less radially arranged hyphal tips to a distinct palisade of globose to vesiculose cells (fig. 2). The surface of the stipe is usually interwoven but may possess caulocystidia and, in the apical portion, be fertile. Clamp connections have not been found. Results of some of the routine chemical reactions do not appear to be highly distinctive.

Although numerous characters have been cited in the above discussion, the fact remains that generic distinction is not based upon the presence of one or two major characters but rather by a combination of several characters. Perhaps the most important single character, at least for field recognition of the genus, is the nature of the tubes. Snell and Dick (1958) have pointed out that the tubes of *Xerocomus* species form a "faveolate" pattern and do not readily separate from one another. They compared their arrangement to that of a honeycomb, which is quite different from the "tubulate" arrangement in other genera in which the tubes are easily separated from one another and which, according to them, "resemble a bundle of slightly cooked spaghetti." This character has been found constant for the California species except for *X. zelleri* which often seems somewhat intermediate. They also mentioned that *Xerocomus badius* was an exception to this pattern. Species belonging to this genus are most frequently confused with those belonging to the genus *Boletus* Fries, and it is the opinion of many that they are not sufficiently distinct to be recognized as belonging to separate genera.

An analysis of the presently known species of *Xerocomus* indicates that they quite probably represent an intergrading series between the genus *Boletus* and the genus *Boletellus* Murr. The characters in common with *Boletus* are obvious and include the general aspect of the fruiting bodies, color of the hymenophore, the absence of lacunose or shaggy reticulations on the stipe as well as the smooth spores which are not excessively long (i.e., less than 20  $\mu$ ). On the other hand the group has an affinity with some of the rough spored species although it may be somewhat less apparent than with *Boletus*. Snell, Singer and Dick (1959), for example, have reported that carpophores of *X. zelleri* examined by them had obscurely roughened spores. Although such a spore character has not been observed in carpophores collected in California by this author, such a spore would clearly indicate a close relationship with *Boletellus*. As a matter of fact they recently transferred *X. zelleri* to *Boletellus* because of the spores and a somewhat intermediate type of tube trama. Further proof of the close relationship of these two genera is seen in *Boletellus mirabilis* (Murr.) Singer. This species has a dry, tomentose pileus and smooth, although large, spores. These characters caused Singer (1940) to place this species in *Xerocomus*; however, because of the large spores and general aspect of the carpophores he (1945a) later trans-





FIGS. 3-4. Basidiospores of *Xerocomus*: 3, *X. truncatus*,  $\times 1750$ ; 4, *X. chrysenteron*,  $\times 1750$ .

ferred it to *Boletellus* which seems to be a more satisfactory disposition of the species.

The number of species of *Xerocomus* occurring in the United States, according to Singer (1962), is twelve. The number which has been found in northern California is five, representing a relatively high percentage of the total number. The species collected here fall into two distinct groups. The first group is represented by *X. subtomentosus* and *X. illudens* and has yellow to ochraceous to olive brown pilei, large, compound pores and more or less yellow to pallid stipes. The other group is composed of *X. chrysenteron*, *X. truncatus* and *X. zelleri* and is characterized by very darkly pigmented (dark brown to almost black) pilei, relatively small pores that change to blue when bruised and red to reddish stipes.

All of the species included in this paper have been collected in the relatively dense mixed forests of the coastal range although *X. subtomentosus* is often found in more open areas, particularly along road cuts. Four of the five species have been found to be relatively abundant but only one collection of *X. illudens* has been made. *Xerocomus subtomentosus* and *X. zelleri* are the most abundant species and the latter fruits for a considerably longer period than any of the other species. One additional species, *X. lenticolor*, was described by Dick and Snell (1960) from collections made in the Mount Shasta area by W. B. Cooke. An examination of the type has shown this species to belong to the genus *Suillus*, thus it is excluded from this paper. Also, *Boletellus mirabilis* has been collected but, as mentioned earlier, since it is no longer considered a member of *Xerocomus* it is likewise excluded.

The collections are in the herbarium of San Francisco State College, San Francisco, California, and the author's accession number is included for each collection studied. The colors appearing in quotations in the species descriptions are those of Ridgway (1912).

KEY TO SPECIES

- Pileus yellow to ochraceous to occasionally umber; if darker (i.e. bister to sepia) then stipe coarsely reticulate.
- Stipe coarsely reticulate from  $\frac{2}{3}$  to entire length.....1. *X. illudens*
- Stipe smooth to granulose, reticulate only at apex if at all.....2. *X. subtomentosus*
- Pileus dark brown to black, usually with reddish, granulose but not reticulate stipe. Spores rounded or subacute at apex.
- Pileus tomentose to velutinous, dark brown to chestnut colored, frequently areolate with age; cuticle composed of interwoven to radially arranged hyphal tips .....4. *X. chrysenteron*
- Pileus conspicuously pruinose at least when young; almost black in color; surface strongly pitted but usually not rimose; cuticle differentiated as a compact palisade of inflated hyphal tips.....5. *X. zelleri*
- Spores truncate at apex.....3. *X. truncatus*

1. XEROCOMUS ILLUDENS (Peck) Singer, Farlowia 2:293. 1945. *Boletus illudens* Peck, Rep. N.Y. St. Mus. 50:108. 1897. *Ceromyces illudens* (Peck) Murr., N. Am. Fl. 9:145. 1910.

Pileus 4–7 cm broad at maturity; convex when young becoming plano-convex to broadly convex with age; surface dry, conspicuously tomentose to velutinous, but not with fibrillose fascicles or scales, often somewhat areolate near the margin; evenly colored near “Saccardo’s umber” to “snuff brown” to occasionally as dark as “bister” to “sepia”; margin incurved, entire. Flesh 1–1.5 cm thick, white, unchanging when bruised or exposed; taste mild, odor not distinctive. Tubes narrowly to broadly and deeply depressed around the stipe; colored “chalcedony yellow” to “bright chalcedony yellow” during all stages of development, unchanging upon exposure, 1–1.5 cm long; pores very large, 1–3 mm, concolorous with tube, unchanging upon bruising. Stipe 6–7 cm long, 1–2 cm broad at the apex; yellow at the apex, becoming “warm buff” to “light buff” toward the base, staining reddish brown when bruised; surface with broad, coarse reticulations extending the full length of the stipe or at least the upper two-thirds of the length, moist to dry; typically crooked; tapering to a point at the base; whitish to pallid mycelium at the base; solid; flesh white, unchanging upon exposure. Spores  $11.2\text{--}13.5 \times 4.0\text{--}6.4 \mu$ , pale yellow to pale ochraceous in KOH, ochraceous in Melzer’s reagent, subfusoid to subellipsoid, not truncate, walls smooth and moderately thickened; basidia  $30\text{--}36 \times 9\text{--}12 \mu$ , hyaline, 4-spored, rarely 2-spored; cystidia  $48\text{--}60 \times 6\text{--}10 \mu$ , scattered to abundant, thin-walled, hyaline, cylindric to subfusoid to occasionally subcapitate or obscurely fusoid-ventricose; tube trama hyaline, obscurely divergent to subparallel to somewhat interwoven, hyphae up to  $6 \mu$  in diam; pileus trama loosely interwoven, hyaline, homogeneous, occasional hyphae up to  $12 \mu$  in diam; hypodermis not strongly differentiated, more compactly interwoven than pileus trama, hyphae up to  $8 \mu$  in diam; cuticle pale yellow in KOH, composed of a tangled, more or less interwoven mass of free hyphal tips which are septate but not distinctively enlarged or differentiated, contents appearing dull yellow in KOH, up to  $7 \mu$  in diam, but narrowed somewhat at the septa; cuticle of stipe typically composed of irregular tangled masses of hyphal tips, the terminal cell of which is typically enlarged and more or less clavate in shape, up to  $12 \mu$  broad and  $30 \mu$  in length; no caulocystidia or caulobasidia seen; clamp connections absent.

Chemical Reactions. KOH—flesh negative to pale yellow; cuticle darkening slightly;  $\text{NH}_4\text{OH}$ —flesh negative; cuticle negative to darkening slightly;  $\text{HCl}$ —flesh negative; cuticle pink;  $\text{HNO}_3$ —flesh negative to pale yellow; cuticle dark red to pink; Sulfoformalin—flesh negative; cuticle pink;  $\text{FeSO}_4$ —flesh negative or becoming pale gray; cuticle negative.

Material Studied. Santa Cruz Co.: *Thiers 10796*.

Discussion. Only one collection of this species has been made and this in the open Ponderosa pine forest near Ben Lomond rather than in the Mendocino region where the other species have been found in relative abundance. Although only a single collection is available for examination, there is little doubt of its identity because of the characteristic



large, coarse network on the stipe. As has been pointed out by Coker (1943) this species is similar in appearance to *X. subtomentosus* with the most consistent difference being the reticulate stipe. In addition the flesh of *X. subtomentosus* frequently changes to blue when bruised or exposed while no change has been observed in *X. illudens*. The microscopic characters of the two species appear very similar.

When compared with collections from the southeastern United States the California material is similar except that the carpophores are more heavily pigmented and are more olive or umber in appearance. The same difference has been noticed between eastern and western carpophores of *X. subtomentosus*.

As far as can be determined this is the first report of this species west of the Rocky Mountains.

2. *XEROCOMUS SUBTOMENTOSUS* (Fries) Quelet, Fl. Mycol. Fr. 418. 1888. *Boletus subtomentosus* Fries, Systema Mycologicum 1:389. 1821. *Ceratomyces subtomentosus* (Fr.) Murr., Mycologia 1:153. 1909. *Ceratomyces oregonensis* Murr., Mycologia 4:97. 1912.

Pileus 6–15 cm broad when fully expanded, convex when young, becoming broadly convex to plano-convex to plane to shallowly depressed at maturity; surface dry, dull, even, conspicuously velutinous to subtomentose to matted tomentose during all stages of development; when young colored “Isabella color” to “tawny olive” to “clay color” to occasionally near “yellow ocher” to “antimony yellow” usually becoming “sayal brown” to “snuff brown” to “buckthorn brown” to “olive ocher” with age; no reddish pigmentation along the margin or in cracks in the flesh, usually not conspicuously areolate; margin entire, incurved to decurved, sometimes staining dark brown when handled. Flesh 1–2.5 cm thick, firm, whitish to pale yellow, often concolorous with the cuticle near the surface, often changing to blue when exposed; taste mild to slightly acid; odor not distinctive. Tubes adnexed to arcuate-decurrent when young, typically becoming shallowly to deeply depressed with age, up to 1 cm long; when young colored “antimony yellow” to “warm buff” changing to “primuline yellow” to “amber yellow” to “honey yellow” to “olive ocher” with age, unchanging or sometimes becoming blue when bruised; pores large, 1–2 mm, angular to highly irregular in outline, often compound, concolorous with tube. Stipe 5–11 cm long, 1–2.5 cm broad at the apex, equal or sometimes narrowing at the base; surface dry, glabrous to granulose to appressed fibrillose or longitudinally ridged, sometimes obscurely reticulate at the apex; colored “Naples yellow” at the apex becoming “tawny” to “ochraceous tawny” in the mid-portion and “warm buff” at the base, occasionally the background color is yellow but heavily overlain with darker colored granulations; often with whitish to yellow mycelium at the base and yellow rhizoids arising from the base; solid; flesh whitish to pale yellow, typically changing to blue when exposed. Spores pale yellow-ochraceous in KOH, smooth, thin-walled, subfusoid to subcylindric,  $11.5\text{--}16 \times 3.5\text{--}5 \mu$ ; basidia clavate, hyaline in KOH,

4-spored,  $27-32 \times 7-9 \mu$  cystidia scattered to numerous, hyaline, thin walled, fusoid to fusoid-ventricose, often with elongated, tapering apices,  $40-66 \times 8-12 \mu$ ; tube trama obscurely divergent to subparallel, with oleiferous hyphae interspersed, hyphae  $\pm 5 \mu$  in diam; pileus trama interwoven, homogeneous except for interspersed oleiferous hyphae; cuticle pale ochraceous yellow in Melzer's reagent and KOH, loosely interwoven with numerous free, septate hyphal tips, often strongly incrustated, hyphae  $5-7 \mu$  in diam; surface of stipe differentiated as a layer of free to loosely interwoven hyphal tips with occasional tufts or clusters of caulocystidia which are hyaline, fusoid to clavate, thin walled,  $24-40 \times 6-9 \mu$ ; clamp connections not present.

Chemical Reactions. KOH—flesh negative to pale yellow; cuticle darkening slightly;  $\text{NH}_4\text{OH}$ —flesh negative; cuticle negative to darkening slightly; HCl—flesh negative; cuticle pink;  $\text{HNO}_3$ —flesh negative to pale yellow; cuticle dark red to pink; Sulfoformalin—flesh negative; cuticle pink;  $\text{FeSO}_4$ —flesh negative or pale gray; cuticle negative.

Material Studied. Marin Co.: *Thiers* 10857, 10872, 11145. Mendocino Co.: *Thiers* 8180, 8183, 8396, 8405, 8817, 8818, 8876, 8877, 9061, 9262, 9292, 9309, 9337, 9348, 9438, 9471, 9767, 10573, 10647, 10676, 11019. Santa Cruz Co.: *Thiers* 8694, 10756, 10771, 10964. San Mateo Co.: *Thiers* 8670, 10926, 11198.

Discussion. This species is common under conifers and hardwoods in the coastal forests and also fruits along road cuts and similarly disturbed areas. The yellow to olive pileus, large, compound pores and more or less yellow stipe distinguish it from members of the complex composed of *X. chrysenteron*, *X. truncatus* and *X. zelleri*. As was indicated for *X. illudens* it is most likely to be confused with that species except for the distinctly reticulate stipe. The stipe of *X. subtomentosus* may be typically longitudinally ridged or granulose but not reticulate except occasionally at the very apex. When compared with midwestern collections the California carpophores appear more heavily pigmented, particularly with olive tones. Also the western carpophores often appear considerably darker when dried than those from other parts of the United States.

Early in this century Murrill (1912) described *Ceriumyces oregonensis* from a collection made in the vicinity of Newport, Oregon. An examination of the type revealed no significant differences between it and *X. subtomentosus*, thus it is reduced to synonymy with that species.

3. *XEROCOMUS TRUNCATUS* Singer, Snell, & Dick ex Snell, Singer, & Dick, *Mycologia* 51: 573. 1959.

Pileus 7.5–12 cm broad when mature; convex when young becoming plano-convex to plane at maturity; surface dry, conspicuously tomentose during all stages of development, relatively smooth and even to sometimes conspicuously areolate; colored near "tawny olive" to "buffy brown" when young darkening to "clove brown" to "olive brown" to "sepia" to "bister" when older, exposed flesh in cracks usually showing reddish tints; margin entire, incurved. Flesh 1–1.5 cm thick, colored "warm buff" to "light buff," unchanging or becoming blue in irregular



areas; taste often acid and somewhat unpleasant; odor not distinctive. Tubes subdecurrent to deeply and often narrowly depressed around the stipe; colored "olive ocher" to "Isabella color" to "old gold," bluing readily when bruised; pores angular, often more than 1 mm. broad, concolorous with tubes, Stipe 8–12 cm long, 1.5–3 cm broad at the apex; equal to tapering slightly toward the base; colored "hydrangea red" to "dark vinaceous" at the apex, becoming colored near "warm buff" to "light buff" to "naphthalene yellow" toward the base, usually with lines or ridges colored near "eugenia red"; bright yellow mycelium at the base; surface dry, glabrous to obscurely punctate or ridged; solid, flesh reddish toward the base, pallid at the apex. Spores  $12.5\text{--}15 \times 4.5\text{--}6.0 \mu$ , tawny to cinnamon in KOH and Melzer's reagent, ellipsoid to subventricose, conspicuously truncate, walls smooth, relatively thick; basidia  $28\text{--}33 \times 7\text{--}10 \mu$ , hyaline, clavate, 4-spored; cystidia scattered to numerous, often staining tawny to ochraceous in KOH, incrustated or filled with amorphous content, clavate to elongated fusoid-ventricose,  $36\text{--}67 \times 10\text{--}14 \mu$ ; tube trama hyaline, obscurely divergent to subparallel, hyphae  $\pm 6 \mu$  in diam; pileus trama loosely interwoven, hyaline, homogeneous, hyphae  $7 \mu$  in diam; cuticle differentiated as a layer of interwoven to more or less radically arranged hyphal tips, often incrustated, staining ochraceous to tawny in KOH, hyphae  $\pm 10 \mu$  in diam; surface of the stipe differentiated as a layer of caulobasidia with numerous sterile hyphal tips interspersed, staining cinnamon to tawny in KOH, tawny oleiferous hyphae scattered throughout; clamp connections not found.

Chemical Reactions. KOH—negative;  $\text{NH}_4\text{OH}$ —negative; HCl—flesh yellowish, cuticle negative;  $\text{HNO}_3$ —negative; Sulfoformalin—flesh pink, cuticle negative;  $\text{FeSO}_4$ —negative.

Material Studied. Marin Co.: *Thiers* 7504, 10875, 11134. Mendocino Co.: *Thiers* 8203, 8462, 8463, 9296. Santa Cruz Co.: *Thiers* 10755, 10786. San Mateo Co.: *Peters* 399. Sonoma Co.: *Thiers* 9412.

Discussion. This species, which appears to fruit under both conifers and hardwoods in the coastal forests, is readily recognized by the conspicuously truncate spores, which all carpophores produce, although not exclusively since a mixture of spores with truncate and with more or less rounded apices has been observed from the same carpophore. *X. truncatus* belongs to the *X. chrysenteron*-*X. truncatus*-*X. zelleri* complex and appears most closely related to *X. chrysenteron*. As pointed out by Snell, Singer and Dick (1959) many workers in the past have confused the two species, and, as was done by Coker (1943), often made special mention that some collections of *X. chrysenteron* had truncate spores while others did not. A re-examination of the collections labelled *X. chrysenteron* in the herbarium of San Francisco State College has revealed that several collections made in Michigan belonged to *X. truncatus*.

It has generally been found that *X. chrysenteron* and *X. truncatus* cannot be distinguished with certainty in the field. Fruit bodies of both species have darkly colored pilei which are usually conspicuously rimose

and stipes that are red to reddish, particularly with age. The cuticle of both species is composed of interwoven to radially arranged, undifferentiated hyphal tips which distinguishes them from *X. zelleri* which has a palisade of inflated hyphal tips.

Although this species was first described from collections made in the state of Washington this, as far as can be determined, is the first report of its presence in California.

4. *XEROCOMUS CHRYSENTERON* (Fries) Quelet, Fl. Mycol. Fr. 418. 1888. *Boletus chrysenteron* Fries, Epicr. Syst. 415. 1836–1838.

Pileus 6–8 cm broad when fully expanded, convex when young changing to broadly convex to plano-convex to plane at maturity; surface dry, dull, velutinous to subtomentose to tomentose, usually shallowly to conspicuously areolate with age, especially near the margin; colored “Saccardo’s umber” to “snuff brown” to occasionally near “sepia” to “bister” during all stages of development; flesh in cracks on disc pallid, often assuming reddish tints toward the margin when older; margin entire, decurved. Flesh 1–1.5 cm thick on the disc, colored “ivory yellow” to “light buff” to “pale chalcedony yellow,” unchanging or becoming blue in irregular areas; taste not distinctive to somewhat acid and unpleasant; odor not distinctive. Tubes arcuate-decurrent to depressed, often narrowly and deeply so in older carpophores; up to 1 cm in length; colored near “reed yellow” to “old gold,” typically changing to blue when bruised; pores typically highly irregular in outline and large (1–1.5 mm), concolorous with the tubes. Stipe 7–10 cm. long, 1–1.7 cm broad at the apex; equal to tapering slightly toward the base; surface dry, glabrous but often longitudinally ridged or striate; usually colored “primrose yellow” at the apex becoming “russet” to “tawny” to “Hays russet” toward the base, sometimes pallid at the base and reddish only in mid-portion or entirely pallid with only the striations or ridges becoming colored near “eugenia red”; whitish to yellow mycelium at the base; solid, flesh pallid to yellowish at the apex, typically changing to reddish toward the base, unchanging when exposed. Spores ochraceous in KOH and Melzer’s reagent, ellipsoid to subventricose to subcylindric, not truncate, smooth,  $12\text{--}13.5 \times 5\text{--}6 \mu$ ; basidia hyaline, 4-spored, clavate,  $33\text{--}36 \times 7\text{--}9 \mu$ ; cystidia scattered to numerous, common only on the tube mouths, fusoid to fusoid-ventricose, hyaline, thin-walled,  $56\text{--}75 \times 10\text{--}13 \mu$ ; tube trama hyaline, obscurely divergent to subparallel, hyphae  $\pm 8 \mu$  in diam; pileus trama homogeneous, interwoven, hyaline, hyphae  $\pm 7 \mu$  in diam; cuticle staining dark cinnamon brown in KOH, composed of tangled masses of hyphal tips which may appear radially arranged, especially when young, often heavily and spirally incrustated, hyphae  $\pm 10 \mu$  in diam; surface of the stipe interwoven, incrustated, staining dark cinnamon brown in KOH; clamp connections absent.

Chemical Reactions. KOH—flesh negative to pinkish yellow, cuticle negative or darkening slightly;  $\text{NH}_4\text{OH}$ —negative; HCl—flesh negative to yellowish, cuticle negative to pinkish;  $\text{HNO}_3$ —flesh and cuticle

negative to pale pink; Sulfoformalin—flesh and cuticle negative to pale pink;  $\text{FeSO}_4$ —negative.

Material Studied. Marin Co.: *Thiers* 8210. Mendocino Co.: *Thiers* 8746, 8778, 8820, 9294, 9343, 9432, 9470, 9617; *Largent* 65, 92. San Mateo Co.: *Thiers* 9452, 10940.

Discussion. This is another species found inhabiting the mixed coniferous-hardwood forests along the northern coast, and is a member of the complex mentioned earlier. Like *X. truncatus* it apparently fruits less commonly than *X. zelleri* but nevertheless is found relatively frequently, particularly in heavily wooded areas. *Xerocomus chrysenteron* is distinguished macroscopically by the dark colored, conspicuously rimose pileus that often has some red pigment in the cracks or along the margin, and microscopically by possessing spores that have rounded (fig. 4) instead of truncate apices and a cuticle of interwoven to radially arranged hyphal tips instead of a compact palisade of inflated cells. For a further discussion of the relationships and characteristics of this species see the discussion for *X. truncatus* and *X. zelleri*.

5. *XEROCOMUS ZELLERI* (Murr.) Snell ex Slipp & Snell, Lloydia 7:43. 1944. *Ceromyces zelleri* Murr., Mycologia 4:99. 1912. *Boletus zelleri* Murr., Mycologia 4:217. 1912. *Boletellus zelleri* (Murr.) Singer, Snell, & Dick, Mycologia 51:575. 1959.

Pileus 5–10 cm broad at maturity; convex to obtusely convex when young becoming convex to plane with age; surface dry to moist, conspicuously white pruinose when young often becoming glabrous to obscurely tomentose to subtomentose with age; typically markedly rugulose to verrucose when young, becoming more or less even or smooth at maturity; not conspicuously areolate when young but sometimes becoming so with age; colored “dusky brown” to “fuscous” to “fuscous black” to “bone brown,” sometimes fading to “army brown” to “natal brown,” often with a reddish margin; margin entire, often becoming eroded with age, incurved when young becoming decurved at maturity. Flesh up to 1.5 cm thick, whitish to pale yellow, unchanging or becoming blue when exposed; taste not distinctive or mildly acid, odor not distinctive. Tubes arcuate-decurrent to depressed, often deeply depressed with age, up to 1.5 cm in length; colored “olive ocher” when young, changing to “honey yellow” with age, typically becoming blue when bruised or exposed; tube mouths highly irregular in outline, typically more than 1 mm; concolorous with the tubes. Stipe 5–8 cm long, 0.7–1.3 cm broad at the apex; equal to occasionally tapering slightly toward the apex; surface dry, typically appearing granulose to punctate, especially toward the base; when young background typically colored near “warm buff” which becomes more or less obscured with granules colored “eugenia red,” sometimes colored “acajou red” at the apex, becoming yellowish with red punctae toward the base, older stipes typically colored “vandyke red” to “madder brown”; white to pale yellow mycelium at the base; solid; flesh yellow when young, typically red when older, sometimes changing to blue in irregular areas when exposed. Spores pale yellow to pale ochraceous in



KOH, ochraceous tawny in Melzer's reagent, subellipsoid to subfusoid to subventricose, smooth,  $12-15 \times 4.0-5.5 \mu$  (occasional giant spores measuring up to  $24 \mu$  in length found in one collection); basidia hyaline, clavate, 4-spored, rarely 1-3 spored,  $18-21 \times 10-11 \mu$ ; cystidia rare to scattered to numerous, apparently lacking in some carpophores, clavate to obtusely fusoid to fusoid-ventricose to obscurely mucronate, hyaline to rarely yellowish in KOH, thin-walled,  $40-85 \times 10-13 \mu$ ; tube trama parallel to obscurely divergent, with a distinct central strand, hyaline, hyphae  $\pm 6 \mu$  broad; pileus trama loosely interwoven, homogeneous, hyphae  $\pm 3 \mu$  broad; cuticle staining dark brown in KOH, differentiated as a turf of free, septate, erect, inflated hyphal tips, often appearing similar to pilocystidia incrustated, typically collapsing and appearing as a tangled mass of hyphal tips in older pilei; surface of stipe interwoven, heavily incrustated with oleiferous hyphae differentiated throughout; clamp connections absent.

Chemical Reactions. KOH—negative;  $\text{NH}_4\text{OH}$ —flesh greenish, cuticle negative; HCl—flesh yellowish; cuticle dark pink;  $\text{HNO}_3$ —flesh and cuticle pink; Sulfoformalin—flesh yellowish, cuticle dark pink;  $\text{FeSO}_4$ —negative.

Material Studied. Marin Co.: *Thiers* 9825, 10874. Mendocino Co.: *Thiers* 8165, 8202, 8290, 8435, 8619, 8790, 8870, 8871, 8993, 9050, 9256, 9289, 9342, 9349, 9722, 9854, 10051, 10643, 10706, 11017, 11076; *Motta* 51, 247; *Peters* 90. Napa Co.: *Largent* 324; Santa Cruz Co.: *Thiers* 9088; *Peters* 349. San Mateo Co.: *Thiers* 7449, 11199.

Discussion. As indicated earlier this is one of the most common species of *Xerocomus* in California and fruits from the onset of the rainy period in the fall until March and April. It was found most frequently in mixed forests, usually in areas where the coastal redwood, *Sequoia sempervirens* (Lamb.) Endl., was relatively abundant. In some instances it was found along the margin of slash burns as well as in restricted clearings within the forests.

This fungus appears to be very closely related to *X. chrysenteron*, and microscopic examination of the cuticle is usually necessary to distinguish them. Generally, however, *X. zelleri* has a darker colored, pruinose pileus which typically does not become strongly rimose-areolate. It has been found, however, that by far the most reliable distinction is in the difference in the structure of the cuticle of the two species. In young pilei of *X. zelleri* the cuticle is differentiated as a closely packed palisade of noticeably enlarged hyphal tips (fig. 1) in which the subterminal cell is globose to pyriform and the terminal cell is somewhat pyramidal in outline. In older pilei these cells sometimes collapse and the cuticle then appears interwoven to radially arranged. In *X. chrysenteron*, on the other hand, the terminal hyphal cells are more or less equal in size and interwoven or more or less radially arranged. Another conspicuous feature of the cuticle of *X. chrysenteron* is the heavy incrustation of the hyphal walls which is often deposited in a spiral pattern.

Recently Singer, Snell, and Dick (1959) transferred this species to *Boletellus* chiefly because of their observation that the spores have slightly roughened walls. Careful attention, including the examination of the spores of local collections under oil with phase attachments as well as under oil with apochromatic objectives failed to reveal any definite roughness or wrinkling of the spore wall. It is possible that their collections were from a different area and represented a different race, or that the roughness was overlooked in the local collections. It would seem, however, that if the spores are so obscurely roughened as to escape detection after such careful examination that it is placing undue emphasis upon such a characteristic to use it as the chief basis for transferring the species not only to a different genus but also to a different family. It would appear preferable to retain the species in its present genus and emend the concept to include species in which the spores are occasionally obscurely roughened. Thus this species is presently retained in *Xerocomus* until further substantiation warrants placing it with the rough spored species.

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